

CLAIMS

What is claimed is:

1. A method for preparing a non-noble transition metal catalyst for the oxidation reduction reaction comprising:
dissolving selenium and $\text{Ru}_3(\text{CO})_{12}$ in an organic solvent;
refluxing the organic solvent;
obtaining a precipitate; and
heating the precipitate to a temperature greater than or equal to 600°C under an inert atmosphere.
2. The method of claim 1 wherein the organic solvent is xylene.
3. The method of claim 1 wherein the temperature is between 600 and 700°C .
4. The method of claim 1 wherein the heating step is for more than 10 hours.
5. The method of claim 4 wherein the heating step is for about 12 hours.
6. The method of claim 1 wherein the inert atmosphere is nitrogen.
7. A non-noble transition metal catalyst prepared by the method of claim 1.
8. The catalyst of claim 7 wherein the catalyst is supported.
9. An electrochemical fuel cell comprising a non-noble transition metal catalyst at the cathode wherein the catalyst is prepared by the method of claim 1.

10. A method for preparing a non-noble transition metal catalyst for the oxidation reduction reaction comprising:

dissolving a metal salt in an aqueous solution, the metal is ruthenium, molybdenum, iron, cobalt, chromium, nickel or tungsten;

precipitating the metal;

introducing a chalcogen, the chalcogen being sulfur or selenium; and

reacting the precipitated metal with the chalcogen by heating under an inert atmosphere.

11. The method of claim 10 wherein the precipitating the metal step comprises adding a reducing agent to the aqueous solution.

12. The method of claim 11 wherein the reducing agent is sodium borohydride or formaldehyde.

13. The method of claim 10 wherein the introducing a chalcogen step comprises adding selenium dioxide to the aqueous solution prior to the precipitating step.

14. The method of claim 13 wherein the precipitating the metal step also causes precipitation of elemental selenium.

15. The method of claim 10 wherein the introducing a chalcogen step comprises adding colloidal sulfur to the aqueous solution prior to the precipitating step.

16. The method of claim 10 wherein the precipitating the metal step comprises adding an alkali solution to the aqueous solution.

17. The method of claim 16 wherein the alkali solution is sodium hydroxide or sodium bicarbonate.

18. The method of claim 10 wherein the metal salt is a ruthenium salt.
19. The method of claim 18 wherein the ruthenium salt is ruthenium (III) chloride, ruthenium (III) nitrate or ruthenium (III) acetate.
20. The method of claim 10 wherein the metal salt is a mixture of at least two different metal salts.
21. The method of claim 10 wherein the heating step is to a temperature greater than or equal to 600°C.
22. The method of claim 21 wherein the heating step is to a temperature between 600°C and 700°C.
23. A non-noble transition metal catalyst prepared by the method of claim 10.
24. The catalyst of claim 23 wherein the catalyst is supported.
25. An electrochemical fuel cell comprising a non-noble transition metal catalyst of claim 23 at the cathode.
26. An electrochemical fuel cell stack comprising at least one electrochemical fuel cell of claim 24.